Science Plan and Possible Canadian Contributions to the Soil Moisture Active and Passive (SMAP) Mission

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1. Historical perspective

The Soil Moisture Active and Passive (SMAP) mission from the National Aeronautics and Space Agency (NASA) will remotely measure L-band emission and backscatter in order to determine soil moisture and surface freeze/thaw state. The measurement of soil moisture and freeze/thaw state has been identified by several Canadian Government Departments as a high-priority for future earth observation systems and was the main motivation for the Canadian Space Agency (CSA) to enter into a partnership with NASA on HYDROS. After HYDROS was stopped, Canadian scientists remained involved in operational soil moisture measurements notably in the context of European Space Agency's SMOS mission for which a data assimilation system is currently being developed.

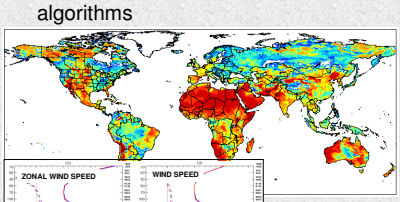
Scientific Themes	Importance of soil moisture and freeze/thaw state of soil
Air quality and emergency response	Soil moisture is, in most regions, a determining factor for surface evaporation and transpiration. Soil moisture influences the evolution of the daytime well-mixed boundary layer, in particular the depth over which pollutants are stirred, which controls the pollutants concentration. Research on the impact of urban and natural surfaces on the boundary layer (and on air quality) over populated areas is still in its early stages.
Agriculture	Soil moisture products (from retrievals or from data assimilation systems) will improve detection, monitoring, and prediction of extreme events, such as droughts and floods. Freeze/thaw transition maps are also of interest to the agriculture community.
Arctic and northern regions	The short revisit time in Northern regions will make it possible for SMAP to provide frequent estimates of sea-ice edge and sea-ice type in Canadian waters, at high-resolution (1-3 km). Estimation of freeze/thaw state is also of interest for Northern studies (e.g., freeze/thaw line, permafrost).
Climate	Soil moisture and freeze/thaw are integral components of the water cycle, which is a primary element of climate predictions. These variables also greatly influence energy and carbon cycles.
Hydrology	Soil moisture and freeze/thaw state are important variables that influence surface runoff and baseflow currents in hydrological models. It is thus a crucial factor in the prediction of floods.
Weather	Soil moisture has already been shown to have a significant impact on short and medium-range weather numerical prediction (low-level air characteristics, clouds and precipitation), through its control on surface evaporation and on the evolution of the boundary layer.

2. Canadian science and technical plans

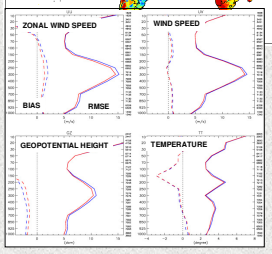
As SMAP was emerging from the ashes of HYDROS in 2007, CSA exchanged with NASA on the possibility of renewing their partnership. CSA, in collaboration with other Canadian Government Departments, is currently developing plans regarding possible scientific and technical contributions to the new mission. The scientific activities would include both government and academic partners.

Scientific plan (for Hydros)

- Assimilation of L-band active and passive data in Environment Canada's Land Data Assimilation System (CaLDAS)
- Evaluation of the impact of L-band soil moisture and freeze/thaw data on numerical weather prediction (short, medium, and long-range forecasts)
- Calibration-validation field experiments to develop and evaluate algorithms used for soil moisture and freeze/thaw retrieval algorithms

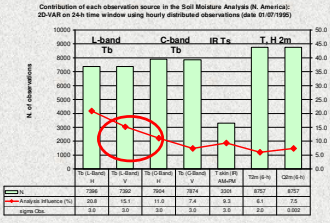


Example of global soil moisture analysis currently operational at the Meteorological Service of Canada, (valid at 0000 UTC 15 December 2001)



Impact of improved soil moisture on medium-range predictions (120h forecasts over Europe). Blue lines show error profiles from a reference experiment; red lines for experiment with improved soil moisture.

Relative contribution of several source of data for the assimilation of soil moisture

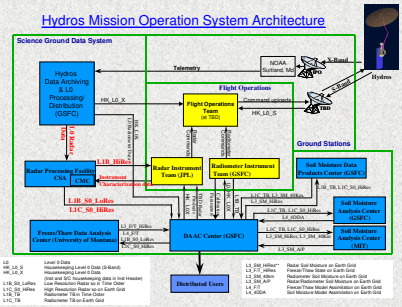


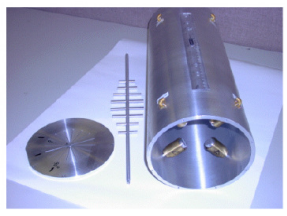
(Balsamo et al., 2008)

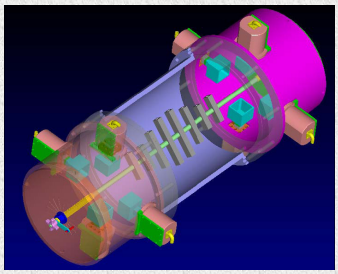
Technical plan (for Hydros)

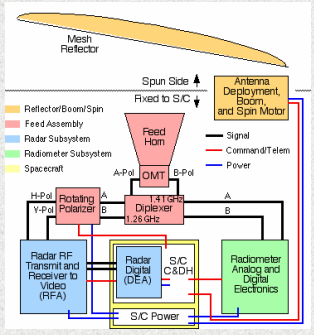
- Design of Antenna and Feed Sub-System
- Radar Processor and Processing Facility

Hydros Mission Operation System Architecture



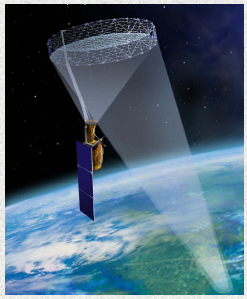






3. Canada's possible contributions to SMAP

CSA has not yet officially confirmed its participation in SMAP. Plans are being prepared to define new contributions taking into account the evolution of system design between Hydros and SMAP. The plans currently being discussed in Canada will serve as a basis for a program review, which is expected to complete in the fall.



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